MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent institution of MAHE, Manipal)

V SEMESTER B. TECH (AERONAUTICAL ENGINEERING)
END-SEMESTER EXAMINATION, DEC., 2021
COURSE: GAS DYNAMICS (AAE 3158)

REVISED CREDIT SYSTEM

Duration: 50 Mins **Date: 23/12/2021** **MAX. MARKS: 30**

PART-A

Q1. A gas is said to be compressible if the variation in density is ____ 0.5 M
1. less than 5%
2. greater than 5%
3. greater than 10%
4. less than 10%

Q2. For a perfect gas, _____ 0.5 M
1. Both C_p and C_v and dependant on temperature
2. C_p is independent and C_v is dependent on temperature
3. C_p is dependent and C_v is independent of temperature
4. Both C_p and C_v are independent of temperature

Q3. The atomic weight of iron is 55.847 amu and oxygen is 15.9994 amu. The molecular weight of ferrous oxide is _____ 0.5 M
1. 159.692 gm/mole
2. 71.846 gm/mole
3. 141.768 gm/mole
4. 92.586 gm/mole

Q4. Air at 310 K and 100 kPa moving at 450 m/s is decelerated isentropic ally to 150 m/s. The final static temperature and pressure are ___ and ____, respectively. 0.5 M
1. 413.4 K, 210.5 kPa
2. 370.7 K, 185,4 kPa
3. 399.6 K, 243.2 kPa
4. 465.2 K, 279.3 kPa

Q5. Air flows from reservoir 1 to reservoir 2 in an irreversible adiabatic manner. The stagnation pressure in the reservoir 1 is three times higher than that of reservoir 2. The entropy difference between the two reservoirs is ___ kJ/kg-K. 0.5 M
1. 345.2
2. 290.5

3. 315.3
4. 412.2

Q6. In a thermally perfect gas, _____ 0.5 M

1. Internal energy and enthalpy are function of both pressure and temperature
2. Internal energy and entropy are function of both pressure and temperature
3. Internal energy and enthalpy are function of only temperature
4. Internal energy and entropy are function of only temperature

Q7. The second law of thermodynamics deals with the ___ 0.5 M

1. conservation of energy
2. direction of energy transfer
3. magnitude of energy transfer
4. conversion of one form of energy into other form

Q8. Hypersonic flow takes place over a wing that is kept at an angle of attack of 15º. According to the Newtonian theory, the pressure coefficient on the suction surface is _____ 0.5 M

1. 0.134
2. 0.185
3. 0.253
4. 0

$C_p = 0$ for suction surface as per Newtonian theory for hypersonic flows

Q9. Hypersonic flow takes place over a wing that is kept at an angle of attack of 12º. The difference in pressure coefficient on the two sides of the wing is 0.43. According to the exact shock wave theory, the lift-to-drag ratio is _____ 0.5 M

1. 4.72
2. 4.67
3. 4.85
4. 4.42

Q10. A flat plate is kept at an angle of 22º in a Mach 6 flow. The Mach number on the top surface of the plate is ____ 0.5 M

1. 4
2. 8
3. 12
4. 9

Q11. For hypersonic flows, _____ method is preferred to determine the aerodynamic properties over the body. 0.5 M

1. Tangent cone method
2. shock expansion method

3. tangent wedge method
4. The tangent cone, tangent wedge and shock expansion methods are equally preferred.

Q12. For Mach 6 flow, the shock wave angle is 8^o. The wedge angle is ____. 0.5 M
1. 6.7^o
2. 9.6^o
3. 5^o
4. 10.4^o

Q13. As compared to supersonic flow, the boundary layer thickness for hypersonic flow is ____ 0.5 M
1. small
2. same
3. large
4. independent of Mach number

Q14. For the same half-cone and half-wedge angles, the intensity of shock wave for a wedge surface is _____ a conical surface. 0.5 M
1. more than
2. weak than
3. same as
4. none of above

Q15. For a given Mach number, with increase in half-cone angle beyond a certain limit, the _____ 0.5 M
1. shock wave becomes attached
2. shock wave becomes detached
3. the expansion fan forms
4. the shock wave intensity reduces

Q16. The slope of characteristic line gives two real characteristics if the flow is _____ 0.5 M
1. Hypersonic
2. sonic
3. supersonic
4. subsonic

Q17. Choose the correct statement regarding the supersonic flows. 0.5 M
1. the region of influence depends up on the domain of dependence
2. the domain of dependence depends up on the region of influence
3. the region of influence and domain of dependence are independent of each other
4. none of above

Q18. The purpose of initial data line is _____ 0.5 M
1. to calculate Mach number at that line
2. to divide the flow-field with respect to that line
3. to calculate the flow properties with respect to that line

4. all above

Q19. In minimum length nozzles, the expansion takes place through _____ 0.5 M

1. expansion section
2. throat section
3. Prandtl-Meyer expansion wave
4. convergent section of nozzle

Q20. In a 2D, steady and supersonic flow, the two characteristic lines make a Mach angle of 23^o. The flow is deflected by 10^o. The slope of left running characteristic line is _____ 0.5 M

1. 0.23
2. 0.53
3. 0.28
4. 0.65

Q21. Choose the wrong statement 0.5 M

1. Linearization theory gives approximate results
2. Linearization theory is applicable for transonic flows
3. While using linearization theory, it is assumed that the perturbations must be small
4. Flow with small perturbations does not guarantee that the governing equation can be linearized.

Q22. A mixture of hydrogen and oxygen enters the combustion chamber at 2600 K and 18 atm. The molecular weight of the gas is 16 and $\gamma = 1.24$. The pressure at the exit of convergent-divergent nozzle is 103×10^{-4} atm. Throat area is 0.3 m^2. Assuming a calorically perfect gas, the exit Mach number is _____ 0.5 M

1. 4.5
2. 5.2
3. 4.85
4. 5.7

Q23. A mixture of hydrogen and oxygen enters the combustion chamber at 2600 K and 18 atm. The molecular weight of the gas is 16 and $\gamma = 1.24$. The pressure at the exit of convergent-divergent nozzle is 103×10^{-4} atm. Throat area is 0.3 m^2. Assuming a calorically perfect gas, the exit velocity is _____m/s. 0.5 M

1. 3184.5
2. 3743.6
3. 3456.3
4. 3267.8

Q24. A mixture of hydrogen and oxygen enters the combustion chamber at 2600 K and 18 atm. The molecular weight of the gas is 16 and $\gamma = 1.24$. The pressure at the exit of convergent-divergent nozzle is 103×10^{-4} atm. Throat area is 0.3 m^2. Assuming a calorically perfect gas, the characteristic density is _____kg/m^3. 0.5 M

1. 0.846
2. 0.839
3. 0.812
4. 0.878

Q25. A mixture of hydrogen and oxygen enters the combustion chamber at 2600 K and 18 atm. The molecular weight of the gas is 16 and $\gamma = 1.24$. The pressure at the exit of convergent-divergent nozzle is 103×10^{-4} atm. Throat area is 0.3 m^2. Assuming a calorically perfect gas, the characteristic speed of sound is _____m/s. 0.5 M

1. 1189
2. 1295
3. 1223
4. 1145

Q26. For a convergent-divergent nozzle, if the nozzle exit pressure is continuously keep on reducing, the shock wave and expansion wave occurs in the order of ____ 0.5 M

1. normal shock wave, expansion wave, oblique shock wave
2. expansion wave, normal shock wave, oblique shock wave
3. oblique shock wave, normal shock wave, expansion wave
4. normal shock wave, oblique shock wave, expansion wave

Q27. A left running oblique shock wave interacts with a free boundary. The reflected wave is ____ 0.5 M

1. left running shock wave
2. right running shock wave
3. expansion wave
4. normal shock wave

Q28. Mach 2.5 flow is deflected through an angle at a compression corner. The normal Mach number upstream of the oblique shock wave is 1.5. The surface deflection angle is ___. 0.5 M

1. 14.9^o
2. 12.3^o
3. 16.6^o
4. 15.3^o

Q29. For subsonic flows, the effect of friction _____ 0.5 M

1. decelerates the flow
2. accelerates the flow
3. doesn't affect the flow speed
4. initially decelerates and then accelerates the flow

Q30. For supersonic flow over a wedge surface, at constant Mach number, with increase in wedge angle, the intensity of the shock wave ___ 0.5 M

1. reduces
2. remains same
3. increases
4. none of above

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Note:

- *All questions are compulsory*
- *Draw a neat diagram wherever necessary*
- *Stepwise answers carry marks*
- *Refer the property table attached with this question paper*

Q1.	Write a note on velocity potential	**[2M]**
Q2.	Using the momentum equation in integral form, derive an expression for the momentum equation in differential form.	**[3M]**
Q3.	A convergent-divergent nozzle with throat area 1000 mm^2 and exit area 3000 mm^2 operates under a stagnation condition of 200 kPa and 45^oC. If a normal shock wave is formed in the nozzle at a location with area 2000 mm^2, determine the (a) exit Mach number (b) exit pressure and (c) the pressure loss experienced by the nozzle.	**[5M]**
Q4.	Describe the procedure to calculate the critical Mach number in compressible flows.	**[2M]**
Q5.	Explain the working principle of hot wire anemometer.	**[3M]**
Q6.	Flow takes place over a symmetric wedge having semi-vertex angle 15^o and Mach number as 2. Determine (a) the shock wave angle with respect to the free-stream direction (b) the pressure ratio across the wave (c) the temperature ratio across the wave (d) the density ratio across the wave (e) the Mach number downstream of the shock wave, assuming the shock wave at the nose to be strong and weak.	**[5M]**